LISTING OF THE CLAIMS

The following is a complete listing of all claims presently in the application, wherein Claims 1-14, 35-52, 55-56, and 62-73 are withdrawn:

1. (withdrawn) A digital dye having an optical change resulting from an electrochemical oxidation/reduction reaction, said digital dye employed in a molecular system that provides two different colors based on two different oxidation states of at least one said digital dye in said molecular system.

2. (withdrawn; previously presented) The optical switch of Claim 57 wherein said at least one digital dye comprises a metal complex.

3. (withdrawn; previously presented) The optical switch of Claim 2 wherein said molecular system is based on the general model below:

$$Con_1\text{—}M^{n+}\ \text{complex}\text{—}Con_2 \underset{-\,e}{\overset{+\,e}{\rightleftharpoons}} Con_1\text{—}\ M^{(n-1)+}\ \text{complex}\text{—}Con_2$$

Oxidized state I, Color I Reduced State II, Color 2

where

Con_1 and Con_2 are optional connecting units between one molecule and another molecule or between a molecule and a substrate, are either a single connecting unit or multiple connecting units, and are selected from the group consisting of hydrogen (utilizing a hydrogen bond), multivalent hetero-atoms selected from the group consisting of C, N, O, S, and P, functional groups containing said hetero atoms, saturated or unsaturated hydrocarbons, and substituted hydrocarbons; and

said metal complex contains hetero atoms selected from the group consisting of N, P, O, S, Se, and Te and combinations thereof, where M has two different oxidation states.

4. (withdrawn; previously presented) The optical switch of Claim 3 wherein said metal complex is represented by one of the following formulae:

$(X)_n M\ L1\ L2$,

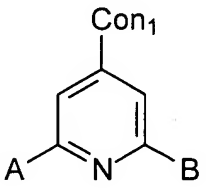
$(X)_2 M\ (L1)_2$, or

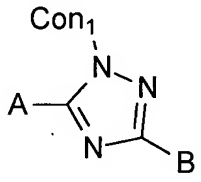
$(L1)_2 M\ L2$,

wherein M represents a metal atom selected from the metals listed in Groups IIIA, IVA, VA, VIA, VIIA, VIIIA, IB, and IIB of the Periodic Table, X represents a polar group, L1 and L2 represent any hetero atom containing ligands which have at least one said connecting group Con_1 or Con_2, and n is an integer between 1 and 8.

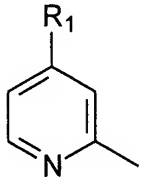
5. (withdrawn; previously presented) The optical switch of Claim 4 wherein M is a Group VIII metal and wherein X is selected from the group consisting of halogen, thiocyanate, hydroxy, cyan, isocyanate, and selenocyan.

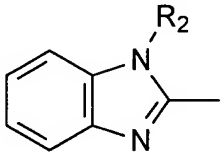
6. (withdrawn; previously presented) The optical switch of Claim 4 wherein L1 and L2 are selected from the group consisting of

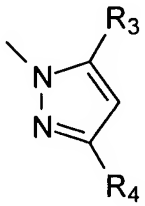


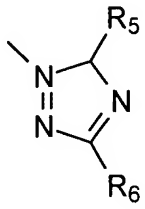
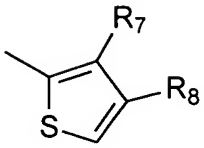
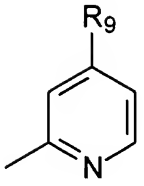


wherein A and B may be the same or different groups independently selected from H and any of the following structures:



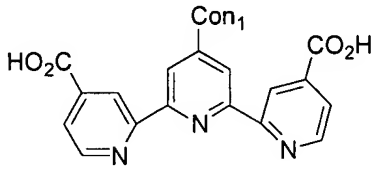
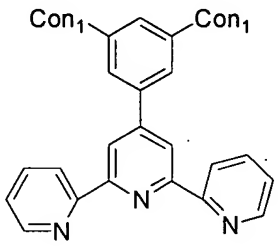
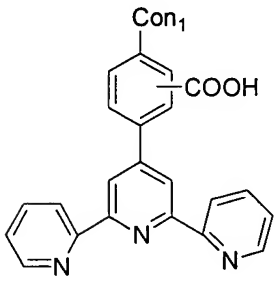
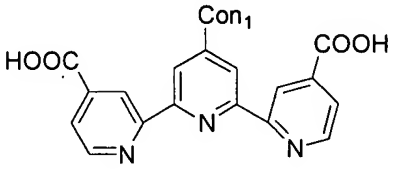
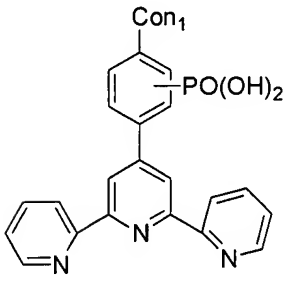
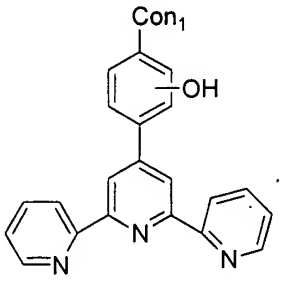




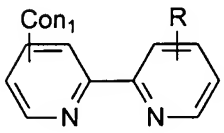




wherein R_1, R_2, R_3, R_4, R_5, R_6, R_7, R_8 and R_9 each represents a hydrogen atom or an organic subsistent such as a hydroxyl group, a lower alkyl group such as C_1-C_6 alkyl group, a lower alloy group such as C_1-C_6 alkoxy group, an unsubstituted amino group or an amino group having a substituent such as a lower alkyl group, e.g., C_1-C_6 alkyl group.

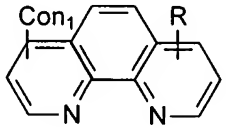
7. (withdrawn; previously presented) The optical switch of Claim 6 wherein L1 and L2 are independently selected from the group consisting of

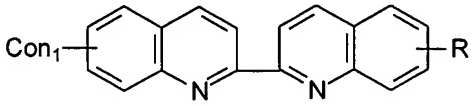
8. (withdrawn; previously presented) The optical switch of Claim 4 wherein L1 and L2 are nitrogen-containing polycyclic compounds selected from the group consisting of bipyridines (I), phenanthrolines (II), and biquinolines (III):



(I)



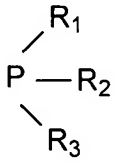
(II)

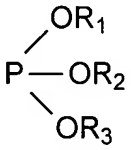


(III)

where R represents a hydrogen atom or an organic substituent selected from the group consisting of hydroxyl, C_1-C_6 alkyl group, C_1-C_6 alkoxy group, an unsubstituted amino group, and an amino group having said substituent.

9. (withdrawn; previously presented) The optical switch of Claim 4 wherein L1 and L2 are selected from the group consisting of triorganophosphines and triorganophosphites having the formula





where each R_1, R_2 or R_3 is the same or different and is a substituted or unsubstituted monovalent hydrocarbon selected from the group consisting of alkyl and aryl groups.

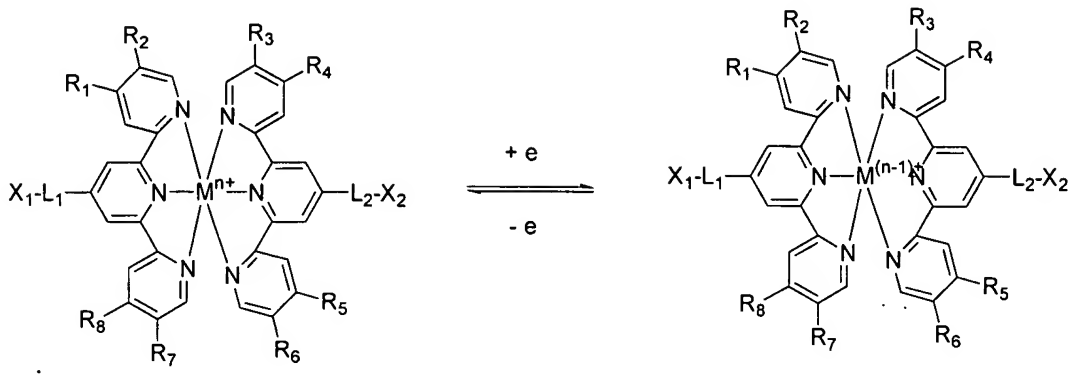
10. (withdrawn; previously presented) The optical switch of Claim 9 wherein said hydrocarbon groups contain from 1 to 24 carbon atoms and wherein said substituted aryl group contains substituent groups selected from the group consisting of alkyl, alkoxy, silyl, amino, substituted amino, acyl, carboxyl, acyloxy, amido, sulfonyl, sulfinyl, sulfenyl, halogen, nitro, cyano, trifluoromethyl, and hydroxy.

11. (withdrawn; previously presented) The optical switch of Claim 10 wherein said alkyl groups are selected from the group consisting of methyl, ethyl, propyl, and butyl, wherein said aryl groups are selected from the group consisting of phenyl, naphthyl, diphenyl fluorophenyl, difluorophenyl, benzoyloxyphenyl, carboethoxy-phenyl, acetylphenyl, ethoxyphenyl, phenoxyphenyl, hydroxyphenyl, carboxyphenyl, trifluoromethylphenyl, methoxyethylphenyl, acetamidophenyl, dimethylcarbamy-phenyl, tolyl, and xylyl.

12. (withdrawn; previously presented) The optical switch of Claim 9 wherein said organophosphine is selected from the group consisting of triphenylphosphine, tri-p-tolylphosphine, tris-p-methoxyphenylphosphine, tris-p-fluorophenylphosphine, tris-p-chlorophenylphosphine, tris-dimethylaminophenyl-phosphine, propyldiphenyl-phosphine, n-hexyldiphenylphosphine, cyclohexyldiphenylphosphine, dicyclohexyl-phenylphosphine, tricyclohexylphosphine, tribenzylphosphine as well as (tri-m-sulfophenyl) phosphine, and (m-sulfophenyl)-diphenylphosphine.

13. (withdrawn; previously presented) The optical switch of Claim 9 wherein said organophosphites is selected from the group consisting of trimethylphosphite, triethylphosphite, butyldiethylphosphite, tri-n-propyl phosphite, tri-n-butyl phosphite, tris-2-ethylhexyl phosphite, tri-n-octyl phosphite, tri-n-dodecyl phosphite, dimethyl-phenyl phosphite, diethyldiphenyl phosphite, tri-phenyl phosphite, trinaphthyl phosphite, bis(3,6,8-tri-t-butyl-2-naphthyl)methylphosphite, bis(3,6,8-tri-t-butyl-2-naphthyl)phos-phite, bis(3,6,,8-tri-t-butyl-2-naphthyl)(4-biphenyl)phosphite, bis(3,6,8-tri-t-butyl-2-naphthyl)(4-benzoylphen-yl)phosphite, and bis(3,6,8-tri-t-butyl-2-naphthyl)(4-sulfonylphenyl)phosphite.

14. (withdrawn; previously presented) The optical switch of Claim 4 wherein said digital dye is represented by



Oxidized state I, Color 1

Reduced State II, Color 2

where

L1-X1 and L2-X2 are independently present or absent, and if present are independently selected from the group consisting of 3-mercaptophenyl, 3-mercaptomethylphenyl, 3-(2-(4-mercaptophenyl)ethynyl)-phenyl, 3-(2-(3-mercaptomethylphenyl)ethynyl) phenyl, 3-(2-(3-hydroseleno-phenyl)ethynyl)phenyl, 3-hydrotellurophenyl, 3-hydrotelluromethylphenyl, 3-(2-(4-hydrotellurophenyl)-ethynyl)phenyl, and 3-(2-(3-hydrotellurophenyl)ethynyl)-phenyl; and

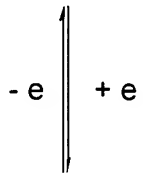
R_1, R_2, R_3, R_4, R_5, R_6, R_7, and R_8 are independently selected from the group consisting of a hydrogen atom, hydrocarbons (either saturated or unsaturated), substituted hydrocarbons, aryl groups, substituted aryl groups, and a functional group which contains at least one atom selected from the group consisting of N, O, S, P, and As.

15. (previously presented) The optical switch of Claim 57 wherein said at least one digital dye comprises a charge complex.

16. (previously presented) The optical switch of Claim 15 wherein said molecular system is based on the general model below:

Con_1——M^{n+} complex—Chromophore—Con_2

Oxidized State I, Color 1



Con_1— $M^{(n-1)+}$ complex—Chromophore—Con_2

Reduced State II, Color 2

Scheme 2

where:

Con_1 and Con_2 are optional connecting units between one molecule and another molecule or between a molecule and a substrate, are either a single connecting unit or multiple connecting units, and are selected from the group consisting of hydrogen (utilizing a hydrogen bond), multivalent hetero-atoms selected from the group consisting of C, N, O, S, and P, functional groups containing said hetero atoms, saturated or unsaturated hydrocarbons, and substituted hydrocarbons;

said metal complex contains at least one hetero atom selected from the group consisting of N, P, O, S, Se, and Te, where M has two different oxidation states; and

said chromophore is a natural or synthetic colorant.

17. (previously presented) The optical switch of Claim 16 wherein said metal complex is represented by one of the following formulae:

$(X)_n$ M L1 L2,

$(X)_2$ M $(L1)_2$, or

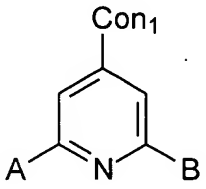
$(L1)_2$ M L2,

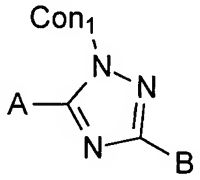
wherein M represents a metal atom selected from the metals listed in Groups IIIA, IVA, VA, VIA, VIIA, VIIIA, IB, and IIB of the Periodic Table, X represents a polar

group, and L1 and L2 represent any hetero atom containing ligands which have at least one said connecting group Con_1 or Con_2, and n is an integer between 1 and 8.

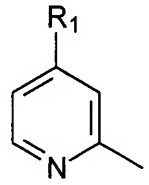
18. (previously presented) The optical switch of Claim 17 wherein M is a Group VIII metal and wherein X is selected from the group consisting of halogen, thiocyanate, hydroxy, cyan, isocyanate, and selenocyan.

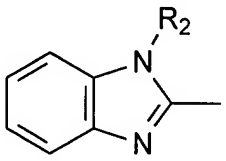
19. (previously presented) The optical switch of Claim 17 wherein L1 and L2 are selected from the group consisting of

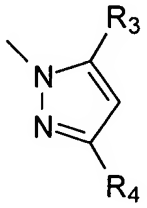


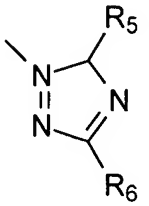


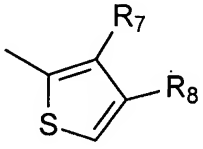
wherein A and B may be the same or different groups independently selected from H and any of the following structures:

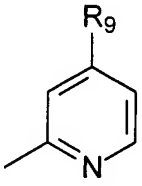








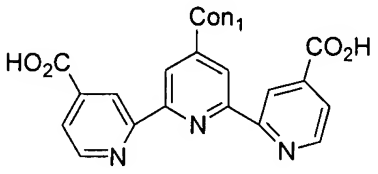


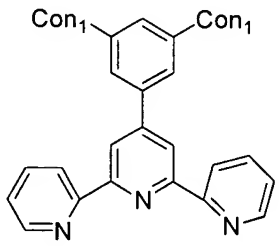


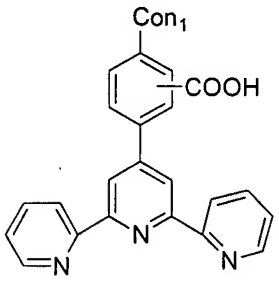
wherein R_1, R_2, R_3, R_4, R_5, R_6, R_7, R_8 and R_9 each represents a hydrogen atom or an organic subsistent such as a hydroxyl group, a lower alkyl group such as C_1-C_6 alkyl

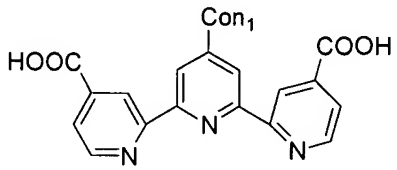
group, a lower alloy group such as C_1-C_6 alkoxy group, an unsubstituted amino group or an amino group having a substituent such as a lower alkyl group, e.g., C1-C_6 alkyl group.

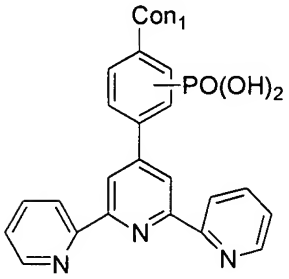
20. (previously presented) The optical switch of Claim 19 wherein L1 and L2 are independently selected from the group consisting of

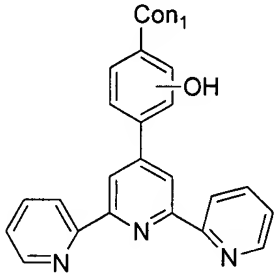




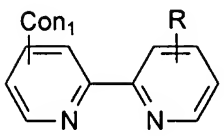




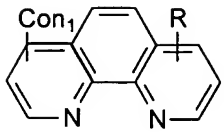




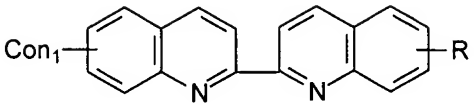
21. (previously presented) The optical switch of Claim 17 wherein L1 and L2 are nitrogen-containing polycyclic compounds selected from the group consisting of bipyridines (I), phenanthrolines (II), and biquinolines (III):



(I)



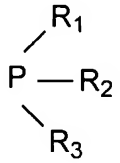
(II)

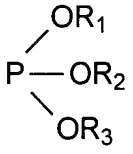


(III)

where R represents a hydrogen atom or an organic substituent selected from the group consisting of hydroxyl, C_1-C_6 alkyl group, C_1-C_6 alkoxy group, an unsubstituted amino group, and an amino group having said substituent.

22. (previously presented) The optical switch of Claim 17 wherein L1 and L2 are selected from the group consisting of triorganophosphines and triorganophosphites having the formula





where each R_1, R_2 or R_3 is the same or different and is a substituted or unsubstituted monovalent hydrocarbon selected from the group consisting of alkyl and aryl groups.

23. (previously presented) The optical switch of Claim 22 wherein said hydrocarbon groups contain from 1 to 24 carbon atoms and wherein said substituted aryl group contains substituent groups selected from the group consisting of alkyl, alkoxy, silyl, amino, substituted amino, acyl, carboxyl, acyloxy, amido, sulfonyl, sulfinyl, sulfenyl, halogen, nitro, cyano, trifluoromethyl and hydroxy.

24. (previously presented) The optical switch of Claim 23 wherein said alkyl groups are selected from the group consisting of methyl, ethyl, propyl, and butyl, wherein said aryl groups are selected from the group consisting of phenyl, naphthyl, diphenyl fluorophenyl, difluorophenyl, benzoyloxyphenyl, carboethoxyphenyl, acetyl-

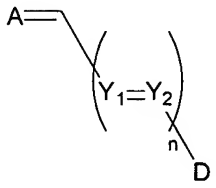
phenyl, ethoxyphenyl, phenoxyphenyl, hydroxyphenyl, carboxyphenyl, trifluoromethylphenyl, methoxyethylphenyl, acetamidophenyl, dimethylcarbamyphenyl, tolyl, and xylyl.

25. (previously presented) The optical switch of Claim 22 wherein said organophosphines are selected from the group consisting of triphenylphosphine, tri-p-tolylphosphine, tris-p-methoxyphenylphosphine, tris-p-fluorophenylphosphine, tris-p-chlorophenylphosphine, tris-dimethylaminophenyl-phosphine, propyldiphenylphosphine, n-hexyldiphenylphosphine, cyclohexyldiphenylphosphine, dicyclohexylphenylphosphine, tricyclohexylphosphine, tribenzylphosphine as well as (tri-m-sulfophenyl) phosphine, and (m-sulfophenyl)-diphenylphosphine.

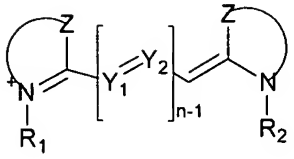
26. (previously presented) The optical switch of Claim 22 wherein said organophosphites are selected from the group consisting of trimethylphosphite, triethylphosphite, butyldiethylphosphite, tri-n-propyl phosphite, tri-n-butyl phosphite, tris-2-ethylhexyl phosphite, tri-n-octyl phosphite, tri-n-dodecyl phosphite, dimethylphenyl phosphite, diethyldiphenyl phosphite, tri-phenyl phosphite, trinaphthyl phosphite, bis(3,6,8-tri-t-butyl-2-naphthyl)methyl-phosphite, bis(3,6,8-tri-t-butyl-2-naphthyl)phosphite, bis(3,6,,8-tri-t-butyl-2-naphthyl)(4-biphenyl)phosphite, bis(3,6,8-tri-t-butyl-2-naphthyl)(4-benzoylphen-yl)phosphite, and bis(3,6,8-tri-t-butyl-2-naphthyl)(4-sulfonylphenyl)phosphite.

27. (previously presented) The optical switch of Claim 17 wherein said colorant is selected from the group consisting of (a) dyes based on polyenes and polymethines; (b) polyarylmethine dyes and their aza analogs; (c) aza [18] annulenes and phthalocyanine colorants; (d) nitro and nitroso dyes; (e) azo dyes and pigments; (f) carbonyl dyes and pigments; and (g) BODIPY dyes.

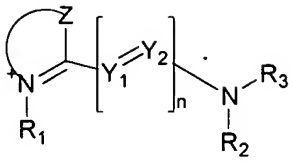
28. (previously presented) The optical switch of Claim 27 wherein said dyes based on polyenes and polymethines are selected from the group consisting of



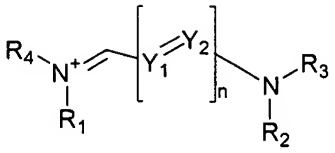
GF1



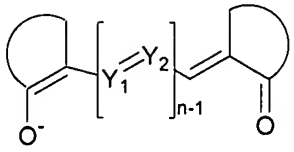
GF2



GF3



GF4



GF5

where:

A is an Acceptor group comprising an electron-withdrawing group selected from the group consisting of (a) carboxylic acid and its derivatives, (b) sulfuric acid and its derivatives, (c) phosphoric acid and its derivatives, (d) nitro, (e) nitrile, (f) hetero atoms selected from the group consisting of N, O, S. P, F, CI, Br), (g) functional groups with at least one of said hetero atoms, (h) saturated or unsaturated hydrocarbons, and (i) substituted hydrocarbons;

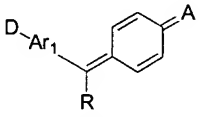
D is a Donor group comprising an electron-donating group selected from the group consisting of (a) hydrogen, (b) amines, (c) OH, (d) SH, (e) ethers, (f) saturated or unsaturated hydrocarbons, (g) substituted hydrocarbons, and (h) functional groups with at least one hetero atom selected from the group consisting of B, Si, I, N, O, S, and P, wherein said Donor group is more electropositive than said Acceptor group;

R_1, R_2 , R_3, and R_4 are property-tuning units selected from the group consisting of (a) hydrogen, (b) multivalent hetero-atoms selected from the group consisting of C, N, O, S, and P, (c) functional groups with at least one of said hetero atoms, (d) saturated or unsaturated hydrocarbons, and (d) substituted hydrocarbons;

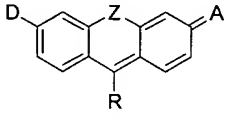
Z is an optional bridging unit for connecting two adjacent aromatic rings together, selected from the group consisting of O, S, NH_2, NHR, and CHR functional groups; and

Y_1 and Y_2 represent connecting units between said Donor and said Acceptor, and are independently selected from the group consisting of CH= and N= units, wherein Y_1=Y_2 can be a single connecting set or multiple connecting sets.

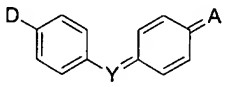
29. (previously presented) The optical switch of Claim 27 wherein said polyarylmethine dyes and their aza analogs are selected from the group consisting of



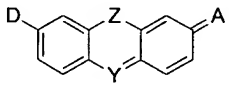
GF6



GF7



GF8



GF9

where:

A is an Acceptor group comprising an electron-withdrawing group selected from the group consisting of (a) carboxylic acid and its derivatives, (b) sulfuric acid and its derivatives, (c) phosphoric acid and its derivatives, (d) nitro, (e) nitrile, (f) hetero atoms selected from the group consisting of N, O, S. P, F, Cl, Br), (g) functional groups with at least one of said hetero atoms, (h) saturated or unsaturated hydrocarbons, and (i) substituted hydrocarbons;

D is a Donor group comprising an electron-donating group selected from the group consisting of (a) hydrogen, (b) amines, (c) OH, (d) SH, (e) ethers, (f) saturated or unsaturated hydrocarbons, (g) substituted hydrocarbons, and (h) functional groups with at least one hetero atom selected from the group consisting of B, Si, I, N, O, S, and P, wherein said Donor group is more electropositive than said Acceptor group;

Y is a connecting unit between said Donor and said Acceptor, and is either a CH= or N= unit;

Z is an optional bridging unit for connecting two adjacent aromatic rings together, selected from the group consisting of O, S, NH_2, NHR, and CHR functional group;

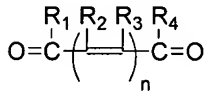
Ar_1 is aromatic ring system; and

R is selected from the group consisting of hydrogen, saturated or unsaturated hydrocarbon, and substituted hydrocarbon.

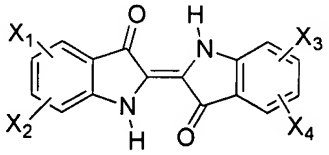
30. (previously presented) The optical switch of Claim 27 wherein in said nitro and nitroso dyes, at least one electron donor groups and at least one nitro group or at least one nitroso group are linked together through an aromatic ring.

31. (previously presented) The optical switch of Claim 27 wherein said azo dyes and pigments are compounds containing (-N=N-) which are linked sp^2-hybridized carbon atoms, wherein said azo groups are either bound to aromatic rings, are aromatic heterocycles or are enolizable aliphatic groups.

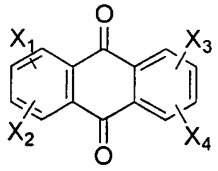
32. (previously presented) The optical switch of Claim 27 wherein said carbonyl dyes and pigments have at least two carbonyl groups that are bound to sp^2-hybridized carbon atoms and are selected from the group consisting of



GF10



GF11



GF12

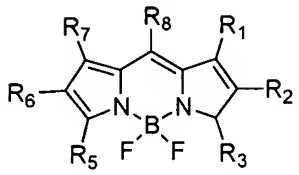
where:

n = 1 to 4;

X_1, X_2 , X_3, and X_4 are some auxochromic tuning units. They may be any one of the following: hydrogen, multivalent hetero-atoms (i.e., C, N, O, S, P, etc.) or functional groups containing these hetero atoms (e.g., NH, PH, etc.), hydrocarbons (either saturated or unsaturated) or substituted hydrocarbons; and

R_1, R_2, R_3, and R_4 may be any one of the following: hydrogen, hydrocarbons (either saturated or unsaturated) or substituted hydrocarbons.

33. (previously presented) The optical switch of Claim 27 wherein said BODIPY dye has a structure given by

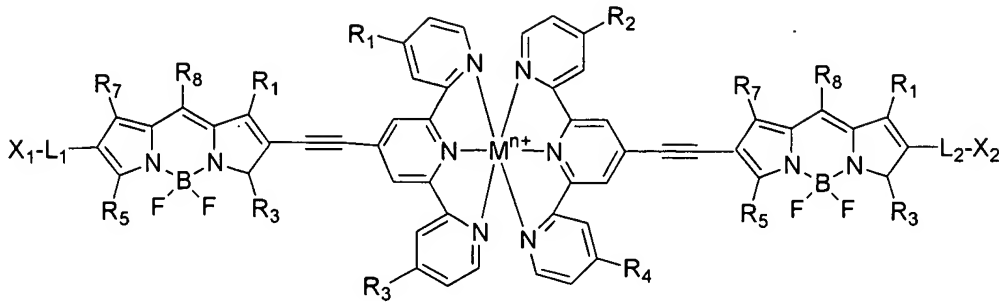


GF13

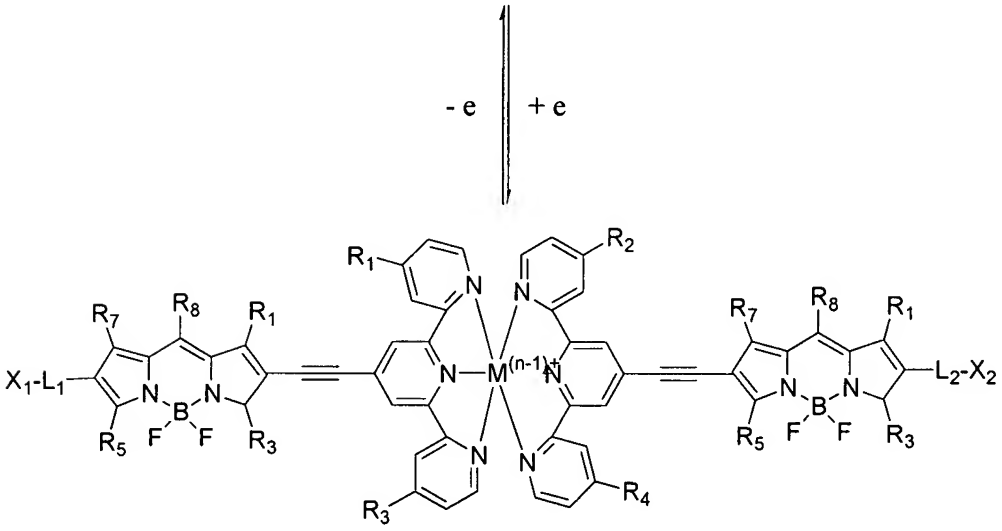
wherein

R_1, R_2, R_3, R_4, R_5, R_6, R_7, and R_8 are independently selected from the group consisting of hydrogen atom, saturated or unsaturated hydrocarbons, substituted hydrocarbons, aryl groups substituted aryl groups, and a functional group containing an atom selected from the group consisting of N, O, S, P, and As.

34. (previously presented) The optical switch of Claim 17 wherein said digital dye is represented by



Oxidized state I, Color 1



Reduced State II, Color 2

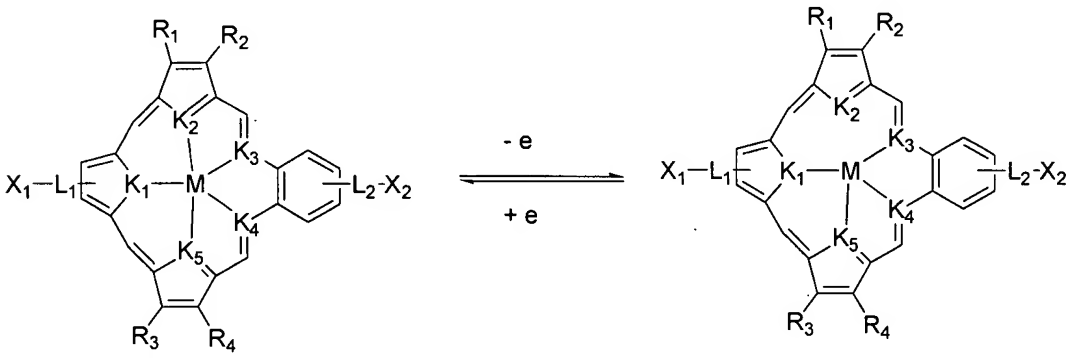
where

L1-X1 and L2-X2 are independently present or absent and if present are independently 3-mercaptophenyl, 3-mercaptomethylphenyl, 3-(2-(4-mercaptophenyl)ethynyl)phenyl, 3-(2-(3-mercaptomethylphenyl)ethynyl)-phenyl, 3-(2-(3-hydroselenophenyl)ethynyl)phenyl, 3-hydrotellurophenyl, 3-hydrotelluromethylphenyl and 3-(2-(4-hydrotellurophenyl)ethynyl)phenyl, or 3-(2-(3-hydrotellurophenyl)-ethynyl)phenyl; and

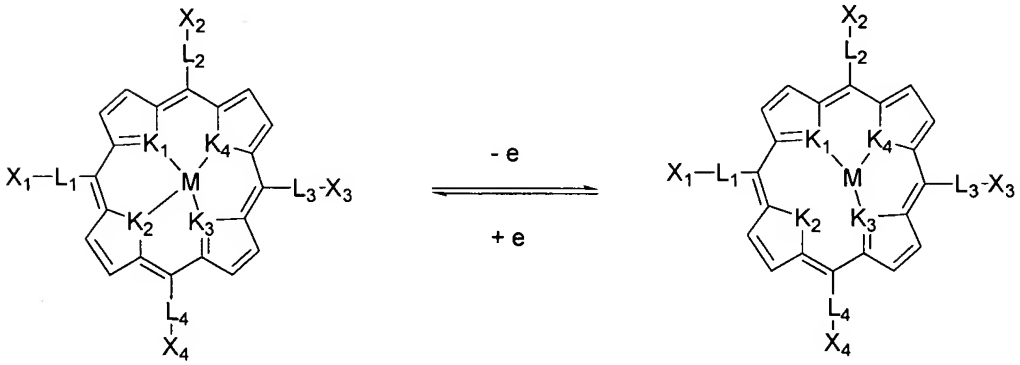
R_1, R_2, R_3, R_4, R_5, R_6, R_7, and R_8 are independently selected from the group consisting of hydrogen atom, saturated or unsaturated hydrocarbons, substituted

hydrocarbons, aryl groups, substituted aryl groups, and functional groups which contains at least one atom selected from the group consisting of N, O, S, P, and As.

35. (withdrawn; previously presented) The optical switch of Claim 17 wherein said molecular system is represented by either molecular system (A) or molecular system (B):



Color 1 (A) Color 2



Color 1 (B) Color 2

where

K1, K2, K3, K4, and K5 are independently selected from the group consisting of N, O, S, Se, Te, and CH;

M is a metal;

L1, L2, L3, and L4 are independently present or absent and if present are linkers;

X1, X2, X3, and X4 are independently selected from the group consisting of a substrate, a reactive site that can covalently couple to a substrate, and a reactive site that can ionically couple to a substrate; and

R1, R2, R3, and R4 are independently selected from the group consisting of aryl, phenyl, cycloalkyl, alkyl, halogen, alkoxy, alkylthio, perfluoroalkyl, perfluoroaryl, pyridyl, cyano, thiocyanate, nitro, amino, alkylamino, acyl, sulfoxyl, sulfonyl, imido, amido, and carbamoyl.

36. (withdrawn; previously presented) The optical switch of Claim 35 wherein said R groups together provide a redox potential range of less than about 5 volts.

37. (withdrawn; previously presented) The optical switch of Claim 36 wherein said redox potential range is less than about 2 volts.

38. (withdrawn; previously presented) The optical switch of Claim 37 wherein said redox potential range is less than about 1 volt.

39. (withdrawn; previously presented) The optical switch of Claim 35 wherein L-X groups can either be eliminated or replaced with at least one substituent independently selected from substituents selected from the group consisting of aryl, phenyl, cycloalkyl, alkyl, halogen, alkoxy, alkylthio, perfluoroalkyl, perfluoroaryl, pyridyl, cyano, thiocyanate, nitro, amino, alkylamino, acyl, sulfoxyl, sulfonyl, imido, amido, and carbamoyl.

40. (withdrawn; previously presented) The optical switch of Claim 39 wherein said substituents together provide a redox potential range of less than about 5 volts.

41. (withdrawn; previously presented) The optical switch of Claim 40 wherein said redox potential range is less than about 2 volts.

42. (withdrawn; previously presented) The optical switch of Claim 41 wherein said redox potential range is less than about 1 volt.

43. (withdrawn; previously presented) The optical switch of Claim 35 wherein M^+ is selected from the group consisting of Li^+, Na^+, K^+, Mg^{2+}, and Ca^{2+}.

44. (withdrawn; previously presented) The optical switch of Claim 35 wherein L1-X1, L2-X2, L3-X3, and L4-X4 are independently present or absent and if present are independently 3-mercaptophenyl, 3-mercaptomethylphenyl, 3-(2-(4-mercaptophenyl)ethynyl)phenyl, 3-(2-(3-mercaptomethylphenyl)ethynyl)phenyl, 3-(2-(3-hydroselenophenyl)ethynyl)phenyl, 3-hydrotellurophenyl, 3-hydrotelluromethylphenyl and 3-(2-(4-hydrotellurophenyl)ethynyl)phenyl, and 3-(2-(3-hydrotellurophenyl)ethynyl)phenyl.

45. (withdrawn; previously presented) The optical switch of Claim 57 wherein said at least one digital dye comprises a conducting polymer system.

46. (withdrawn; previously presented) The optical switch of Claim 45 wherein said molecular system is based on the general model below:

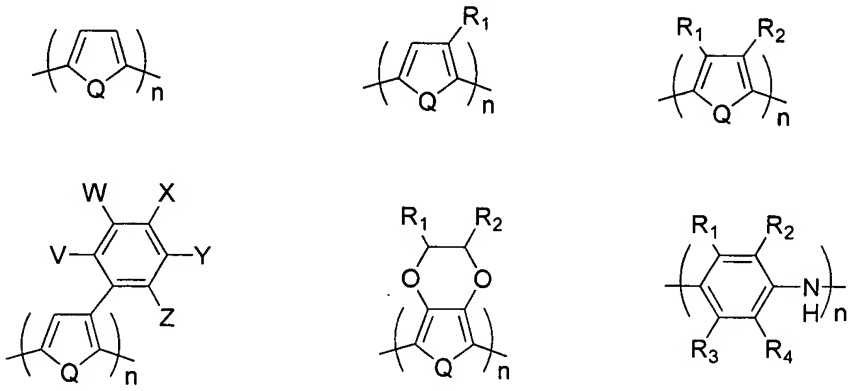
$$\underset{\text{Reduced state I, Color 1}}{Con_1\text{—Conductive polymer—}Con_2} \underset{-\,e}{\overset{+\,e}{\rightleftharpoons}} \underset{\text{Reduced state II, Color 2}}{Con_1\text{—Conductive polymer—}Con_2}$$

where

Con_1 and Con_2 are optional connecting units between one molecule and another molecule or between a molecule and a substrate, are either a single connecting unit or multiple connecting units, and are selected from the group consisting of hydrogen (utilizing a hydrogen bond), multivalent hetero-atoms selected from the group consisting of C, N, O, S, and P, functional groups containing said hetero atoms, saturated or unsaturated hydrocarbons, and substituted hydrocarbons; and

said conductive polymer is a polymer that can be either oxidized or reduced electrochemically and reversibly.

47. (withdrawn; previously presented) The optical switch of Claim 46 wherein said conductive polymer is selected from the group consisting of



where:

Q is a heteroatom selected from the group consisting of N, O, Se, and Te; and

R_1, R_2, R_3, R_4, V, W, X, Y, and Z are substituents that are independently absent or present and if present are independently selected from the group consisting of aryl, phenyl, cycloalkyl, alkyl, halogen, alkoxy, alkylthio, perfluoroalkyl, perfluoroaryl, pyridyl, cyano, thiocyanate, nitro, amino, alkylamino, acyl, sulfoxyl, sulfonyl, imido, amido, and carbamoyl.

48. (withdrawn; previously presented) The optical switch of Claim 47 wherein said substituents together provide a redox potential range of less than about 5 volts.

49. (withdrawn; previously presented) The optical switch of Claim 48 wherein said redox potential range is less than about 2 volts.

50. (withdrawn; previously presented) The optical switch of Claim 49 wherein said redox potential range is less than about 1 volt.

51. (withdrawn; previously presented) The optical switch of Claim 46 wherein said conducting polymer is a polymer that is obtained by electrolytic oxidative po-

lymerization, by chemical oxidative polymerization or by photooxidative polymerization of heterocyclic compounds.

52. (withdrawn; previously presented) The optical switch of Claim 51 wherein said heterocyclic compound is selected from the group consisting of (a) pyrrole, (b) pyrrole derivatives having a substituent at the nitrogen atom or the 3-and/or 4-positions thereof, (c) thiophene, (d) thiophene derivatives having a substituent at the 3-and/or 4-positions thereof; (e) aromatic compounds selected from the group consisting of anilines, alkyl-substituted anilines, phenols, thiophenols, and derivatives thereof, (f) poly(p-phenylene), and (g) polyacetylene.

53. (previously presented) The optical switch of Claim 57 wherein said digital dye has two ends and includes a linking group on at least one said end to form said molecular system.

54. (previously presented) The optical switch of Claim 53 wherein said chemical bonding is achieved with terminal groups on said digital dye selected from the group consisting of thiols, thiol-terminated alkenes, and -COOH-terminated chains or groups.

55. (withdrawn) The digital dye of Claim 1 wherein said molecular system includes at least one said digital dye.

56. (withdrawn) The molecular system of Claim 55 wherein each said at least one digital dye has two ends, and further including a linking group on at least one said end.

57. (previously presented) An optical switch comprising a molecular system disposed between a pair of electrodes capable of generating an electric field, said molecular system providing two different colors based on two different oxidation states of at least one digital dye in said molecular system, said digital dye having an optical change resulting from an electrochemical oxidation/reduction reaction.

58. (original) The optical switch of Claim 57 wherein said molecular system changes between a transparent state and a colored state.

59. (original) The optical switch of Claim 57 wherein said molecular system changes between one colored state and another colored state.

60. (original) The optical switch of Claim 57 wherein said molecular system changes between one index of refraction and another index of refraction.

61. (original) The optical switch of Claim 57 for assembling devices selected from the group consisting of displays, electronic books, rewritable media, electrically tunable optical lenses, electrically controlled tinting for windows and mirrors, and optical crossbar switches for routing signals from one of many incoming channels to one of many outgoing channels.

62. (withdrawn) A display device including a transparent display electrode, a counter electrode, and a molecular system disposed therebetween, said molecular system providing two different colors based on two different oxidation states of at least one said digital dye in said molecular system, said digital dye having an optical change resulting from an electrochemical oxidation/reduction reaction.

63. (withdrawn) The display device of Claim 62 wherein said molecular system is chemically bonded to at least one of said electrodes.

64. (withdrawn) The display device of Claim 63 wherein said molecular system is chemically bonded to both said electrodes.

65. (withdrawn) The display device of Claim 63 wherein said chemical bonding is achieved with terminal groups on said digital dye selected from the group consisting of thiols, thiol-terminated alkenes, and -COOH-terminated chains or groups.

66. (withdrawn) The display device of Claim 62 wherein said at least one digital dye comprises a metal complex.

67. (withdrawn) The display device of Claim 64 wherein said molecular system is based on the general model below:

$$Con_1\text{—}M^{n+}\ \text{complex}\text{—}Con_2 \underset{-e}{\overset{+e}{\rightleftharpoons}} Con_1\text{—}\ M^{(n-1)+}\ \text{complex}\text{–}Con_2$$

Oxidized state I, Color I Reduced State II, Color 2

where

Con_1 and Con_2 are optional connecting units between one molecule and another molecule or between a molecule and a substrate, are either a single connecting unit or multiple connecting units, and are selected from the group consisting of hydrogen (utilizing a hydrogen bond), multivalent hetero-atoms selected from the group consisting of C, N, O, S, and P, functional groups containing said hetero atoms, saturated or unsaturated hydrocarbons, and substituted hydrocarbons; and

said metal complex contains hetero atoms selected from the group consisting of N, P, O, S, Se, and Te and combinations thereof, where M has two different oxidation states.

68. (withdrawn) The display device of Claim 67 wherein said metal complex is represented by one of the following formulae:

$(X)_n$ M L1 L2,

$(X)_2$ M $(L1)_2$, or

$(L1)_2$ M L2,

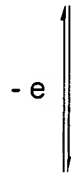
wherein M represents a metal atom selected from the metals listed in Groups IIIA, IVA, VA, VIA, VIIA, VIIIA, IB, and IIB of the Periodic Table, X represents a polar group, L1 and L2 represent any hetero atom containing ligands which have at least one said connecting group Con_1 or Con_2, and n is an integer between 1 and 8.

69. (withdrawn) The display device of Claim 62 wherein said at least one digital dye comprises a charge complex.

70. (withdrawn) The display device of Claim 69 wherein said molecular system is based on the general model below:

Con_1——M^{n+} complex—Chromophore—Con_2

Oxidized State I, Color 1



Con_1— $M^{(n-1)+}$ complex-Chromophore—Con_2

Reduced State II, Color 2

Scheme 2

where:

Con_1 and Con_2 are optional connecting units between one molecule and another molecule or between a molecule and a substrate, are either a single connecting unit or multiple connecting units, and are selected from the group consisting of hydrogen (utilizing a hydrogen bond), multivalent hetero-atoms selected from the group consisting of C, N, O, S, and P, functional groups containing said hetero atoms, saturated or unsaturated hydrocarbons, and substituted hydrocarbons;

said metal complex contains at least one hetero atom selected from the group consisting of N, P, O, S, Se, and Te, where M has two different oxidation states; and

said chromophore is a natural or synthetic colorant.

71. (withdrawn) The display device of Claim 70 wherein said metal complex is represented by one of the following formulae:

$(X)_n$ M L1 L2,

$(X)_2$ M $(L1)_2$, or

$(L1)_2$ M L2,

wherein M represents a metal atom selected from the metals listed in Groups IIIA, IVA, VA, VIA, VIIA, VIIIA, IB, and IIB of the Periodic Table, X represents a polar group, and L1 and L2 represent any hetero atom containing ligands which have at least one said connecting group Con_1 or Con_2, and n is an integer between 1 and 8.

72. (withdrawn) The display device of Claim 62 wherein said at least one digital dye comprises a conducting polymer system.

73. (withdrawn) The display device of Claim 72 wherein said molecular system is based on the general model below:

$$Con_1\text{—Conductive polymer—}Con_2 \underset{-\,e}{\overset{+\,e}{\rightleftharpoons}} Con_1\text{—Conductive polymer—}Con_2$$

Reduced state I, Color 1 Reduced state II, Color 2

where

Con_1 and Con_2 are optional connecting units between one molecule and another molecule or between a molecule and a substrate, are either a single connecting unit or multiple connecting units, and are selected from the group consisting of hydrogen (utilizing a hydrogen bond), multivalent hetero-atoms selected from the group consisting of C, N, O, S, and P, functional groups containing said hetero atoms, saturated or unsaturated hydrocarbons, and substituted hydrocarbons; and

said conductive polymer is a polymer that can be either oxidized or reduced electrochemically and reversibly.

74. (previously presented) A plurality of the optical switches of Claim 57 forming a display device.